REMARKS

The Office Action dated December 21, 2004 has been received and carefully noted. The above amendments to the claims, and the following remarks, are submitted as a full and complete response thereto. Claims 23 and 44-49 have been amended and claims 50-56 have been added. No new matter has been entered. Claims 23-38 and 40-56 are pending in the instant application and examination thereof is respectfully requested.

Claims 23-27, 29-38 and 40-49 were rejected under 35 U.S.C. § 103(a) as being unpatentable over *Helms* (U.S. Patent Pub. 2001/0014592) in view of *Carney et al.* (U.S. Patent No. 5,937,011). The above rejections are respectfully traversed based on the comments that follow.

The present invention is directed, according to claim 23, to a multi frequency carrier transmitter. The transmitter includes input means for receiving a plurality of different digital signals to be transmitted, the different digital signals to be transmitted on different carrier frequencies, digital modulators for modulating the different digital signal at respective modulation frequencies, digital to analog converter means for converting a composite digital signal comprising the different digital signals at the respective carrier frequencies to analog form, thereby generating a composite analog signal, amplifier means for receiving and amplifying the composite analog signal and predistortion means for predistorting the plurality of different digital signals during or after modulation of the different digital signals by the digital modulators and prior to amplification of the

composite analog signal by the amplifier means. The predistortion provided by the predistortion means is subsequently altered in dependence on differences between each of the different digital signals and the output at the amplifier means.

The present invention is directed, according to claim 44, to a multi carrier frequency transmission method. The steps of the method include receiving a plurality of different digital signals to be transmitted, the different signals to be transmitted on different carrier frequencies, modulating the different digital signals at respective modulation frequencies, combining the plurality of different digital signals to provide a composite digital signal comprising the different digital signals at the respective carrier frequencies, converting the composite digital signal to analog form, thereby generating a composite analog signal and amplifying the composite analog signal. The method further includes predistorting the plurality of different digital signals prior to amplification of the composite analog signal by the amplification means during or after the modulation step and altering the predistortion applied to subsequent digital signals in dependence on the difference between each of the different digital signals and the amplified signal.

The present invention is directed, according to claim 45, to a multi frequency carrier transmitter. The transmitter includes input means for receiving a plurality of different digital signals to be transmitted, the different digital signals to be transmitted on different carrier frequencies, digital modulators for modulating the different digital signals at respective modulation frequencies and combining means for receiving the different digital signals modulated at the respective frequencies to generate a composite

digital signal. The transmitter also includes digital to analog converter means for converting the composite digital signal to analog form, generating a composite analog signal, amplifier means for receiving the composite analog signal and amplifying the composite analog signal and predistortion means for predistorting the plurality of digital signals during or after modulation of the different digital signals by the digital modulators and prior to combination of the different digital signals by the combining means, the predistortion provided by the predistortion means being subsequently altered in dependence on a difference between each of the input different digital signals and an output at the amplifier means.

The present invention is directed, according to claim 46, to a multi frequency carrier transmitter. The transmitter includes input means for receiving a plurality of different digital signals to be transmitted, the different digital signals to be transmitted on different carrier frequencies, digital modulators for modulating the different digital signals at respective modulation frequencies, digital to analog converter means for converting a composite digital signal comprising the different digital signals at the respective carrier frequencies to analog form, generating a composite analog signal and amplifier means for receiving and amplifying the composite analog signal. The transmitter also includes predistortion means for predistorting the plurality of digital signals during or after modulation of the different digital signals by the digital modulators and prior to amplification of the composite digital signal by the amplifier means, the predistortion provided by a the predistortion means being subsequently altered in

dependence on a difference between each of the input different digital signals and a plurality of different digital sample signals. The transmitter also includes analog to digital conversion means for converting a sample of the output of the amplifier means into digital form to generate a composite digital sample signal and chanelizing means for converting the composite digital sample signal into the plurality of different digital sample signals.

The present invention is directed, according to claim 47, to a multi frequency carrier transmitter. The transmitter includes an input for receiving a plurality of different digital signals to be transmitted, the different digital signals to be transmitted on different carrier frequencies, a plurality of digital modulators for modulating the different digital signal at respective modulation frequencies, a digital to analog converter for converting a composite digital signal comprising the different digital signals at the respective carrier frequencies to analog form, generating a composite analog signal, an amplifier for receiving and amplifying the composite analog signal and a predistorter for predistorting the plurality of different digital signals during or after modulation of the different digital signals by the digital modulators and prior to amplification of the composite digital signal by the amplifier, the predistortion provided by the predistorter being subsequently altered in dependence on a difference between each of the different digital signals and the output at the amplifier.

The present invention is directed, according to claim 48, to a multi frequency carrier transmitter. The transmitter includes an input for receiving a plurality of different

digital signals to be transmitted, the different digital signals to be transmitted on different carrier frequencies, a plurality of digital modulators for modulating the different digital signals at respective modulation frequencies, a combiner for receiving the different digital signals modulated at the respective frequencies to generate a composite digital signal and a digital to analog converter for converting the composite digital signal to analog form, generating a composite analog signal. The transmitter includes an amplifier for receiving the composite analog signal and amplifying the composite analog signal and a predistorter for predistorting the plurality of different digital signals during or after modulation of the different signals by the digital modulators and prior to combination of the different digital signals by the combiner, the predistortion provided by the predistorter being subsequently altered in dependence on a difference between the each of different digital signals and an output at the amplifier.

The present invention is directed, according to claim 49, to a multi frequency carrier transmitter. The transmitter includes an input for receiving a plurality of different digital signals to be transmitted, the different digital signals to be transmitted on different carrier frequencies, a plurality of digital modulators for modulating the different digital signals at respective modulation frequencies, a digital to analog converter for converting a composite digital signal comprising the different digital signals at the respective carrier frequencies to analog form, generating a composite analog signal, an amplifier for receiving and amplifying the composite analog signal, a predistorter for predistorting the plurality of different digital signals during or after modulation of the different digital

signals by the digital modulators and prior to amplification of the composite digital signal by the amplifier, the predistortion provided by a the predistorter being subsequently altered in dependence on a difference between each of the input different digital signals and a plurality of different digital sample signals, an analog to digital converter for converting a sample of the output of the amplifier into digital form to generate a composite digital sample signal and a chanelizer for converting the composite digital sample signal into the plurality of different digital sample signals.

The present invention is directed, according to claim 50, to a multi frequency carrier transmitter. The transmitter includes input means for receiving a plurality of different digital signals to be transmitted, the different digital signals to be transmitted on different carrier frequencies, digital modulators for modulating the different digital signal at respective modulation frequencies, the modulation frequencies being an intermediate frequency and digital to analog converter means for converting a composite digital signal comprising the different digital signals at the respective carrier frequencies to analog form, thereby generating a composite analog signal. The transmitter also includes amplifier means for receiving and amplifying the composite analog signal and predistortion means for predistorting the plurality of different digital signals during or after modulation of the different digital signals by the digital modulators at the intermediate frequency and prior to amplification of the composite analog signal by the amplifier means, the predistortion provided by the predistortion means being

subsequently altered in dependence on differences between each of the different digital signals and the output at the amplifier means.

The present invention is directed, according to claim 51, to a multi carrier frequency method. The method includes the steps of receiving a plurality of different digital signals to be transmitted, the different signals to be transmitted on different carrier frequencies, modulating the different digital signals at respective modulation frequencies, the modulation frequencies being an intermediate frequency and combining the plurality of different digital signals to provide a composite digital signal comprising the different digital signals at the respective carrier frequencies. The method also includes converting the composite digital signal to analog form, thereby generating a composite analog signal and amplifying the composite analog signal. The method further includes the steps of predistorting the plurality of different digital signals prior to amplification of the composite analog signal by the amplification means during or after the modulation of the different digital signals by the modulating means at the intermediate frequency and altering the predistortion applied to subsequent digital signals in dependence on the difference between each of the different digital signals and the amplified signal.

The present invention is directed, according to claim 52, to a multi frequency carrier transmitter. The transmitter includes input means for receiving a plurality of different digital signals to be transmitted, the different digital signals to be transmitted on different carrier frequencies, digital modulators for modulating the different digital signals at respective modulation frequencies, the modulation frequencies being an

intermediate frequency, combining means for receiving the different digital signals modulated at the respective frequencies to generate a composite digital signal, digital to analog converter means for converting the composite digital signal to analog form, generating a composite analog signal, amplifier means for receiving the composite analog signal and amplifying the composite analog signal and predistortion means for predistorting the plurality of digital signals during or after modulation of the different digital signals by the digital modulators at the intermediate frequency and prior to combination of the different digital signals by the combining means, the predistortion provided by the predistortion means being subsequently altered in dependence on a difference between the input different digital signals and an output at the amplifier means.

The present invention is directed, according to claim 53, to a multi frequency carrier transmitter. The transmitter includes input means for receiving a plurality of different digital signals to be transmitted, the different digital signals to be transmitted on different carrier frequencies, digital modulators for modulating the different digital signals at respective modulation frequencies, the modulation frequencies being an intermediate frequency and digital to analog converter means for converting a composite digital signal comprising the different digital signals at the respective carrier frequencies to analog form, generating a composite analog signal. The transmitter also includes amplifier means for receiving and amplifying the composite analog signal, predistortion means for predistorting the plurality of digital signals during or after modulation of the

different digital signals by the digital modulators at the intermediate frequency and prior to amplification of the composite digital signal by the amplifier means, the predistortion provided by a the predistortion means being subsequently altered in dependence on a difference between each of the different digital signals and a plurality of different digital sample signals, analog to digital conversion means for converting a sample of the output of the amplifier means into digital form to generate a composite digital sample signal and chanelizing means for converting the composite digital sample signal into the plurality of different digital sample signals.

The present invention is directed, according to claim 54, to a multi frequency carrier transmitter. The transmitter includes an input for receiving a plurality of different digital signals to be transmitted, the different digital signals to be transmitted on different carrier frequencies, a plurality of digital modulators for modulating the different digital signals at respective modulation frequencies, the modulation frequencies being an intermediate frequency and a digital to analog converter for converting a composite digital signal comprising the different digital signals at the respective carrier frequencies to analog form, generating a composite analog signal. The transmitter also includes an amplifier for receiving and amplifying the composite analog signal and a predistorter for predistorting the plurality of different digital signals during or after modulation of the different digital signals by the digital modulators at the intermediate frequency and prior to amplification of the composite digital signal by the amplifier, the predistortion

provided by the predistorter being subsequently altered in dependence on a difference between each of the different digital signals and the output at the amplifier.

The present invention is directed, according to claim 55, to a multi frequency carrier transmitter. The transmitter includes an input for receiving a plurality of different digital signals to be transmitted, the different digital signals to be transmitted on different carrier frequencies, a plurality of digital modulators for modulating the different digital signals at respective modulation frequencies, the modulation frequencies being an intermediate frequency and a combiner for receiving the different digital signals modulated at the respective frequencies to generate a composite digital signal. The transmitter also includes a digital to analog converter for converting the composite digital signal to analog form, generating a composite analog signal, an amplifier for receiving the composite analog signal and amplifying the composite analog signal and a predistorter for predistorting the plurality of different digital signals during or after modulation of the different signals by the digital modulators at the intermediate frequency and prior to combination of the different digital signals by the combiner, the predistortion provided by the predistorter being subsequently altered in dependence on a difference between each of the different digital signals and an output at the amplifier.

The present invention is directed, according to claim 56, to a multi frequency carrier transmitter. The transmitter includes an input for receiving a plurality of different digital signals to be transmitted, the different digital signals to be transmitted on different carrier frequencies, a plurality of digital modulators for modulating the different digital

signals at respective modulation frequencies, the modulation frequencies being an intermediate frequency and a digital to analog converter for converting a composite digital signal comprising the different digital signals at the respective carrier frequencies to analog form, generating a composite analog signal. The transmitter also includes an amplifier for receiving and amplifying the composite analog signal, a predistorter for predistorting the plurality of different digital signals during or after modulation of the different digital signals by the digital modulators at the intermediate frequency and prior to amplification of the composite digital signal by the amplifier, the predistortion provided by a the predistorter being subsequently altered in dependence on a difference between each of the different digital signals and a plurality of different digital sample signals, an analog to digital converter for converting a sample of the output of the amplifier into digital form to generate a composite digital sample signal and a chanelizer for converting the composite digital sample signal into the plurality of different digital sample signals.

Generally, the present invention describes a multi frequency carrier transmitter for the transmission of a plurality of different digital signals. In order to compensate for non-linearities in the power amplifier, a predistorter is used to compensate. The predistortion is performed during or after the modulation of the digital signals onto an intermediate frequency (IF). The predistortion is performed in dependence on differences between each of the different digital input signals and the output from the power amplifier.

With respect to the cited prior art, *Carney et al.* and *Helms*, Applicants note that this art was previously cited in the prior Office Action, and thus its discussion need not be repeated. Applicants respectfully assert that the present invention, as claimed in independent claims 23 and 44-49, is neither taught nor suggested by the cited prior art.

The Office Action has alleged that the present invention is obvious over *Helms* in view of *Carney et al.* The Office Action acknowledges that *Helms* does not disclose the input means and modulator means of the present invention, but argues that it would have been obvious for one of ordinary skill in the art to use the modulators disclosed in *Carney et al* to perform this function at the input to the *Helms* invention. Applicants respectfully assert that this is incorrect, and submit that the present invention is not obvious in view of *Helms* and *Carney et al*.

Applicants continue to assert that a modulation step is already included in *Helms*, and this is performed at the digital up-conversion stage (DUC), which runs counter to the combination of *Helms* and *Carney et al.* Well-known IQ digital modulators known in the art comprise a pair of in-phase (I) and quadrature (Q) signals which are input to a pair of mixers. These mixers also have as an input a local oscillator signal that up-converts the input to a higher frequency. The local oscillator signal for the quadrature input is phase shifted by 90° before being input to the mixer. The two outputs from the mixer are then summed together, giving rise to a single modulated output. For more information on digital modulators, please see the document "Digital Modulation in Communications

Systems – An Introduction," of which Figure 8, at page 10, shows a modulator of the type described above.

Figure 4 of *Helms* clearly shows that the DUC block takes as an input the IQ components of the digital input signal, performs "a shift to a digital intermediate frequency" (paragraph [0031] *Helms*), and produces a single output. If this is compared to the diagram shown in Figure 33, on page 35, of the above-mentioned document, which shows a digital transmitter system, it can clearly be seen that the block performing this exact function is labelled as the modulator.

Applicants respectfully submit that the DUC must be performing the equivalent function of a digital modulator. This being the case, then regardless of how the function of the modulating means of *Carney et al.* is interpreted, the combination of *Helms* and *Carney et al.* would not have predistortion performed "during or after modulation… in dependence on differences between each of said different digital signals and the output at said amplifier means," as recited in the claims. Furthermore, one of ordinary skill in the art would have no motivation to apply the modulators of *Carney et al.* to the input of *Helms*, as there would be no benefit of having two modulation stages.

In addition, even if this line of reasoning is somehow not accepted, i.e. that the DUC block is equivalent to the modulator of the present invention, and it is merely performing an up-shift in frequency as part of the combining task, it can be shown that the use of modulators such as those disclosed in *Carney et al.* would not provide the required form of input signals as needed by the invention in *Helms*. Thus, there would be

no reason why one of ordinary skill in the art would combine the teachings of *Helms* and *Carney et al.*

The Office Action provides that the modulating means of *Carney et al.* are suitable to "form or obtain the carrier signals (in1, ..., inn), as required by Helms." Applicants respectfully assert that this is not correct. The modulator of *Carney et al.* modulates the input signals, and yet it is stated that they remain at baseband (column 3, line 33). Therefore, it can be assumed that the input signals are modulated in order to achieve the required frequency spacing between each of the inputs, such that when they are combined, they form a set of signals separated in frequency (but still at baseband). This is supported by column 3, line 40-43, of *Carney et al.* Applicants respectfully assert that input signals in this form are <u>not</u> suitable for use in the invention disclosed in *Helms*.

Applicants assert that the input signals to the invention in *Helms* (in1, ..., inn) are all required to be at the same baseband frequency, and not equally spaced apart over a frequency bandwidth. The reason for this lies with the DUC blocks shown in Figure 4 of *Helms*. It can clearly be seen that there is a separate DUC block for every input signal. Each of these DUC blocks up-converts the signal to an IF frequency. If the inputs (in1, ..., inn) were already spaced apart equally in frequency (as is done by the modulators of *Carney et al.*), then each of these DUC blocks would be performing exactly the same frequency up-conversion for each of input signals, such that each signal was simply a certain, fixed value higher in frequency.

This would therefore make the use of separate DUC blocks redundant, as the operation could be equally well performed by a single DUC block after the signals had been summed together (as is done in *Carney et al*). Rather, Applicants respectfully assert that it is clear that the input signals of *Helms* should all be at the same baseband frequency, and then these are subsequently up-converted by different amounts by the separate DUC blocks in order to space the inputs apart in frequency prior to summation.

Helms states that the inputs consist of "carrier-related input signals" (paragraph [0028]). This does not give any indication that they are anything other than simple baseband signals with no frequency shifts. The term "carrier-related" only seems to indicate that each of the signals is "destined" to be modulated onto a separate carrier frequency in the transmitter, and does not indicate that it has any special properties at this stage of the device.

Thus, one of ordinary skill in the art would not have been motivated to apply the modulator of *Carney et al* to *Helms*, as the multiple DUC blocks are then performing a redundant operation. One of ordinary skill in the art would realize that the modulators of *Carney et al.* would not be suitable, and would not be motivated to combine the inventions.

If the proposed modification or combination of the prior art would change the principle of operation of the prior art invention being modified, then the teachings of the references are not sufficient to render the claims prima facie obvious. In re Ratti, 270 F.2d 810, 123 USPQ 349 (CCPA 1959). In the present case, an actual combination of

Carney et al with *Helms*, would render *Helms* unfit for its intended purposes. For this additional reason, Applicants respectfully assert that the combination of *Helms* and *Carney et al* is improper and the rejection relying thereon should be withdrawn.

Furthermore, it is stated that the input signals of *Helms* "consist of an in-phase component I and a quadrature component Q" (paragraph [0028] *Helms*). There is no indication that the modulator of *Carney et al.* would output an IQ signal. In fact, as stated above, it is common in the art for an IQ signal to form the input of a digital modulator, rather than an output.

Overall, Applicants cannot envisage any type of modulator being suitable for use at the input of *Helms*. As discussed above, the inputs must all be at the same baseband frequency for *Helms* to function correctly. Since the very definition of a modulator is a device that combines an information signal with a carrier signal, it is hard to see how such a device is needed when the input signals all remain at an equal baseband frequency. This only strengthens the previous argument that the modulation in *Helms* is performed at the DUC stage.

Therefore, Applicants respectfully assert that the present invention, as recited in independent claims 23 and 44-49, is clearly inventive over the cited prior art of *Carney et al.* and *Helms*, and no reasonable combination of these documents could result in the present invention.

Simlarly, the newly added independent claims 50-56 include the feature that the modulation is performed at an intermediate frequency. Neither *Carney et al.* nor *Helms*

disclose this feature. Both systems disclosed in *Carney et al.* and *Helms* may perform modulation at baseband, and the up-conversion to IF takes place later. Applicants respectfully assert that the present invention, as recited in independent claims 50-56, is clearly inventive over the cited prior art of *Carney et al.* and *Helms*, and no reasonable combination of these documents could result in the present invention.

If for any reason the Examiner determines that the application is not now in condition for allowance, it is respectfully requested that the Examiner contact, by telephone, the applicant's undersigned attorney at the indicated telephone number to arrange for an interview to expedite the disposition of this application.

In the event this paper is not being timely filed, the Applicants respectfully petitions for an appropriate extension of time. Any fees for such an extension together with any additional fees may be charged to Counsel's Deposit Account 50-2222.

Respectfully submitted,

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